T

h
C
h
e
p
b

d
b
tr
n
d

F
w
a
re

T

THE SANITARY ENGINEERING CO'Y

OF TORONTO.

(LIMITED).

PREFACE.

THE following pages are dedicated to those seeking a solution of the "*sewage disposal*" problem, and are offered in the hope that the several matters herein set forth may induce Health Officials, Inspectors, Municipal Authorities, Engineers and others having sanitary affairs within their jurisdiction, to seriously enquire into this most important subject, and to ascertain by personal investigation, the grand sanitary results which are before us.

Not only is *water-carried-sewage* effectually and permanently disposed of, no matter how the city, town or local institution may be situated, but all garbage, house-refuse, etc., is *absolutely destroyed*, and the sanitary condition of the district so perfected that no feeding ground is retained for the collection, propagation or distribution of disease germs.

A saleable, and easily handled fertilizer, technically known as *Poudrette*, is the product of our sewage precipitation process, and we ask your careful perusal of the following facts and statements, a large proportion of which is from actual experience, and the remainder compiled from standard authorities and scientific data:

"Sanitas Sanitatis, Omnia Sanitas."

F. STRAITH-MILLER,
President.

A. B. BARRY,
Engineer and Secretary.

TORONTO, 2nd December, 1889.

THE

SANITARY ENGINEERING CO'Y

OF TORONTO,

(LIMITED).

"Sanitary Engineering has been defined as that branch of "engineering which has for its object the improvement of the "health of towns and districts by bringing to them a supply of "those things which promote health, and carrying from them "those things which are injurious to it."

"STALEY & PIERSON."

Within the last few years much earnest attention has been drawn to the vital and ever present question of *sewage disposal,* and although many minds have been concentrated upon this matter, and large sums of money spent in experiments (as witness the costly outlays in London for one year alone, which amounted to over $240,000.00), no practical or permanent scheme developed itself until the principle of chemical precipitation was first proposed.

This was over forty years ago, previous to that the sewage-farm, sewage irrigation, downward and upward filtration, the deadly lime process, treatment by iron salts in sewers, and, oldest of all, the unsophisticated system of an entire or partial discharge into water ways, had each and all been tried and found wanting, but owing to the inadequate knowledge and means then at the disposal of experimenters nothing much was accomplished until within the last six or seven years. However, numerous precipitants had been brought forward and investigated, prolonged experiments carried out, and generally the way was being prepared for a more enlightened legislation in Sanitary matters, and

a more liberal spirit engendered amongst Health Officials and Municipal Officers; the result being that many far fetched theories were exploded, new ideas interchanged, several old methods scientifically and thoroughly investigated so as to ascertain the actual cause of former failures; numerous chemical, electrical, mechanical, æration and filtration schemes were exhaustively experimented with, and the particular defects and advantageous features in each demonstrated, and thereby much new light thrown upon the ultimate course to be pursued.

At one time slacked lime (patented in 1802, by Estienee), either alone or in combination with certain salts, was much in favor, chiefly on account of the quick action which it produced in precipitating a portion of the mechanically suspended sewage matter, and the temporary bright but impure effluent which it produced; but as the purification was only apparent and temporary, and the dissolved fæcal and uric matter, that is, that portion which was not merely held in suspension, was neither coagulated nor precipitated, this process was almost universally condemned by leading scientific and practical men, and it was not until after, literally speaking, millions of dollars had been wasted, that the result was summed up by stating that "*the process produced secondary decomposition of the most dangerous character, and that the cure was worse than the disease.*"

Then the treatment by iron salts had a long trial. During the past forty or fifty years many towns in England experimented extensively with it, but the results did not justify its continuance or the expectation of the promoters, some of whom promised all sorts of impossible things, amongst which might be mentioned "that it would effectually prevent or destroy sewer gas," again, "that it would destroy such a large proportion of the sewage matter that very little sludge would remain," etc., but although, as is well known, certain salts of iron act as splendid disinfectants, yet something more than this is necessary to perfectly purify water-carried sewage.

For a long time an attempted solution of the sewage disposal difficulty was practised on the Continent of Europe, and also in many parts of England. Those who have visited Belgium, Holland, Germany and France cannot fail to have noticed the long rows of ditches through which the sewage was conducted or allowed to flow. In some places the whole process consisted in permitting the sewage to filter through the intervening land, or that which was raised between the ditches; in others the trenches were scooped out by manual labor, and the muck thrown over the land; then again the sewage was discharged from pipes or drains laid beneath the surface, the idea being to prevent an

actual contact between air and sewage; the latter, being discharged in the subsoil, caused a certain amount of upward filtration before reaching the surface, and thereby (it was thought) perfectly freeing the sewage from all sources of danger; but subsequent experience proved that, although filtration through soil will arrest the suspended particles of matter contained in the sewage, that in chemical combination was not touched and still possessed, upon reaching the surface or finding its way downward into wells, etc., its full powers of decomposition, and was still a carrier of disease germs. This was conclusively demonstrated in the "Swiss village of Lausen, near Basle, which was "supplied with water from a spring, situated at the foot of a "mountainous ridge, called the Stockholden. In this village, "where there had not been a single case of fever in many years, "an epidemic of typhoid fever broke out, which struck down "seventeen per cent. of the whole population. The cases of fever "were pretty evenly distributed among the families in the village, "with the exception of six. As the six families which escaped "did not use water from the spring, suspicions were aroused concerning the water, and investigations were made. It had previously been noticed that when the meadows in the Furlerthal "—a little valley on the other side of the Stockholden ridge— "were irrigated, the volume of water in the spring was increased, "and by the sinking of the soil in one of the meadows in the "Furlerthal, a vein of water was discovered which, it was supposed, led to the spring in Lausen. It was found, upon investigation, that a peasant, living in the Furlerthal, had returned "home from a distant city sick with fever, and that the brook in "which his clothes had been washed, and into which the slops "from the house had been thrown, had been used to irrigate the "meadows. The water thus spread out over the fields and then "filtered through the ridge, a distance of a mile, still carried the "germs of disease in it, and brought death to the unsuspecting "inhabitants of Lausen.

"To prove, conclusively, that the spring was supplied from the "Furlerathal, and to determine whether the water passed through "an open vein or was filtered through porous material, the following experiments were made:—Several hundred weight of "salt was dissolved and poured in the hole in the Furlerthal, "where the vein was discovered. In a few hours the water of "the spring became very salt, and the connection between the "water in the Furlerthal and the spring at Launsen was established beyond a doubt.

"They now mixed two and a half tons of flour in water and "poured it into the hole, but no trace of the flour could be found

"in the spring; proving that the water was so thoroughly filtered "as to remove the minutest particles of flour, and yet it still "retained its infective properties."

"CADY STALEY & GEORGE S. PIERSON, C. E."

When a district has been properly drained and the sewage scientifically disposed of, a visible effect upon the Public Health and a marked diminution of the death rate is observable.

The experience, for instance, in Southampton is astonishing. Previous to adoption of the "Carbon" system of sewage precipitation, the annual mortality was 21.96 per 1,000, but *within a year* after the system was in operation, the death rate had fallen to 14.26 per 1,000, or a saving of over 300 lives yearly. Comment is unnecessary.

The result of scientific investigation and prolonged experiment at last pointed towards a much more practical and sanitary method, and that was the use of such an agent that would cause perfect separation of all matter held both in chemical and mechanical suspension, and to act not only as a precipitant, but as an oxidising agent. This idea of course necessitated the collection and retention of water-carried sewage in suitable receptacles until the desired action was accomplished, the partial chemical treatment *in* sewers not having proved at all satisfactory after many years' trial. In fact, under date 14th October, 1889, the London *Standard* reported that "The Guildford Rural Sanitary "Authority spent some time on Saturday in discussing the pollu-"tion of the River Wye and the best means to adopt to prevent "it. Last month the state of the river was so bad, that on one "day cartloads of poisoned fish were taken from it," and although this town is the residence of the "Condor System" inventor, who has had it before the public for so very many years, yet the authorities had to look elsewhere for relief and actually petitioned the County Board for "information, advice, and assistance."

Of course there have been many patents taken out for chemical precipitants and several systems placed on exhibition; but it was not until the city of Southampton, in England, took the lead and became the first to demonstrate the practical solution of a question which had effectually eluded the grasp of scientists for generations, by adopting the Patent Carbon process, under the direction of the well-known Engineer Mr. Bennett, that a positive success was achieved, and results, upon a scientific, practical and sound financial basis, were fully demonstrated.

The true principle of sanitation is undoubtedly to return to the soil the chemical constituents originally contained in it, and

which had been exhausted and absorbed by crops, fruit, vegetables, pasturage, etc., and also to make that retu n in a manner neither injurious nor offensive to the surrounding inhabitants.

In the first place, a suitable system of glazed or cement pipe drains should be laid, properly graded, so as to be self-cleaning, the joints so perfectly made that they resist alike the influx of subsoil water *into* the pipe, and the efflux of sewage *out* of it. There should be as few sharp turns as possible, the change of direction being accomplished by long bends. The pipes should be of such a capacity that ample provision is made for storm water, unless the separate system is contemplated, when the sewer, being confined to the conveyance of sewage proper, need only be of a capacity to convey a percentage above the maximum water supply of the district; the storm water sewer taking care of rainfall, street detritus, etc.

Whenever possible, brick drains should never be used for conveyance of sewage; but should this be unavoidable, then the inside course or lining must be of glazed or impervious brick, to prevent the saturation of liquid matter into and through the walls of sewer, and thence to the soil, where it would accumulate and form a dangerous nucleous of decomposed matter. Ordinary building brick is so porous that it really absorbs sewage matter, and becomes converted into a fœtid receptacle of death-dealing gases and disease germs. Take for instance a brick from one of our ordinary sewers, and the result of a Biological examination will reveal a state of decomposed filth teaming with micro-organisms of such a character that the abnormal prevalence of sickness, and the high death rate is no longer a secret.

The time is not far distant when cement, iron, or steel sewers, will be universally adopted for diameters of 24 inches and upwards. The former are now made in England of large oval sections, and when the fall is properly arranged, are of ample proportions to convey the sewage from our present largest cities, and, by a slight modification, could be constructed of any required diameter or section.

When the proper slope has been given to sewer pipes, to insure, say an average velocity of 3 feet per second, the necessity for ventilation does not exist to the same extent as in brick sewers or slowly-flowing sewage, the former are not so easily cleaned, and by the silting up or daming of heavy particles the sewage is formed into a succession of pools which are only cleansed by flushing or an unusual rainfall; the smooth surface of either glazed or cement pipes facilitates the flow of sewage, or, properly speaking, does not retard the same by undue friction, consequently the entire contents from the farthest part is discharged at the outfall,

and can be treated before decomposition has had time to set in, or germ life to develop, thereby preventing the formation of "sewer gas," *which only occurs in badly constructed drains, never otherwise;* a proper prevention is to either connect the sewer with the smoke stack of some large factory, or else to build a ventilating shaft, which will create sufficient current to ensure perfect ventilation. In some cases this is conveniently accomplished by connecting the same with the destructor for destroying garbage and house refuse. Connections for house services should be at *top* of sewer not at side, and when made with loose reversable junctions will facilitate connections and obviate the necessity of cutting into sewer at all.

The cause of so much sickness and death in our cities, towns, and villages is the careless manner in which excremental matter is disposed of and the almost criminal method of filling up hollows, with garbage, etc.

We can all call to mind some instance of the ingenuity displayed in designing and constructing a special arrangement for the reception of fæcal matter, especially in our cities, amongst which is the ever-present "cesspool," either open or closed, water-tight or the reverse, the latter being the rule; then there is the rural first-class accommodation "*for guests only,*" which we find all over the continent to-day, and which may be termed the doctor's or undertaker's best friend. It generally consists of a boarded in-space, with a door ostensibly for perennial cleaning purposes, but the whereabouts of which has long since been lost to sight, either by the accumulation of debris or stable sweepings; the "closet" is above on the first or second floor, and the fœtid odor permeating the hotel infallibly directs the "guest" in search of this abomination, and then in the yard matters are in confusion, worse than chaos, a constant leakage must inevitably find its way into the well close by, and so the evil consequences of water pollution are propagated, and disease spread amongst both man and beast.

In many localities, having a small brook or stream running through it, the cesspools, closets, etc., drain either directly into, or towards it, and so on throughout the entire American continent, lack of the very elements of sanitation appear wherever the traveller goes, and the sage authorities look unutterably wise, but DO nothing.

The town being equipped with its sewage system, a water supply is of course essential, and when this has been secured our precipitation process commences here at the outfall of the sewers, from whence the sewage is conveyed by suitable means, according to the configuration of the ground to the storage or settling

tanks, and there treated by our patent carbon, about which a word is now necessary.

Some few years since a powerful company was formed in London, England, to acquire and work an extensive deposit of a remarkable lignite which had been discovered in Devonshire, and with which experiments had been conducted on a prolonged and costly scale, the result being the production of a thoroughly practical precipitating and oxidising agent known as Patent Precipitating Carbon, the action of which upon sewage is as follows :—

First. By its coagulent properties it collects all solid, flocculent, and minute organic matter held in suspension and solution, and so brings them together, that a distinct separation as regards sewage and water is at once visible.

Second. By its specific gravity, which is greatly in excess of water, it becomes entangled in the flocculent matter first formed, and gradually precipitates the same to the bottom.

Third. By its absorbtive powers it collects and renders harmless the gases which have formed or are in process of formation.

Fourth It is the strongest deoderant, disinfectant, and defecant known.

Fifth. Owing to its well-known properties of holding oxygen in a concentrated form within its pores, it acts as a powerful oxidizer, and literally burns up the germ life and organic matter which abounds in sewage water, the effluent is also purified by aeration, the liberated oxygen from the carbon acting in a similar manner to purification by the forced admission of atmospheric air, or to the natural rippling action of running water in streams and rivers.

Sixth. An absolute sterilization of the sewage is effected.

Seventh. Besides its marvellous oxidising, deodorizing, and decolarizing properties, it is also very rich in iron, alumina, magnesia, etc., all of which are chemical agents of greal value, in fact, numerous schemes are in use which claim extraordinary properties for them, either singly or in combination.

Eighth. The perfect separation of sewage into water and sludge renders it easily and quickly handled, and the precipitating action being so rapid, the capacity of tanks is less than by any other known method.

The chemical potentiality in the native lignite was latent, and therefore needed liberation before being made use of. Amongst other processes to which the crude material is subjected, is the incorporation of certain mineral acids, which convert the iron, alumina, etc., into soluble salts, so that the material now contains all the best known properties desirable for the perfect treatment of sewage.

"In virtue of its remarkable porosity and richness in carbon, "it acts as a carrier of atmospheric oxygen, bringing that power-"ful purifier in its most active condition on the surface of its "pores, into intimate and actual contact with the oxidised mat-"ters in the sewage, and in virtue of its specific gravity, nearly "twice as great as water, its particles act as little weights, which "becoming entangled in the chemical coagulum, the whole mass "is quickly dragged down, leaving an effluent of good quality."

Its useful offices are not even now completed, for the same chemical properties which aid so much in purifying the sewage, add, in a most important degree to the workable and valuable properties of the sludge when converted into "Poudrette."

The entire fertilizing or plant life property originally exhausted from the soil, is collected and retained in this precipitated sludge and by careful manipulation is produced in that condition most applicable for use. "Poudrette," unlike excremental matter deposited upon sewage farms, is innocuous and practically inodorous, and being in a highly concentrated and dry, friable state, can be shipped where required at a low cost for transportation, and commands a good price. Baron Liebig, perhaps the best authority on such matters, stated that town sewage was worth 6s. 8d. per unit of population per annum, and further, each unit could supply, with the nitrogen absorbed from the atmosphere sufficient manurial matter to raise from an acre of ground the richest possible crop every year.

Boussingault, also stated that an adult gave off in excrement nearly 16½ pounds of nitrogen yearly, and which he considered sufficient for the yield of 800 pounds wheat and 900 pounds barley.

By reference to the Pentateuch, it is interesting to note the sanitary law laid upon the Israelites, viz., that excrements should not be permitted to lie upon the ground, but must be dug into the soil, as Slater justly remarks: "This command evidently im-"plies a knowledge of the sanitary efficacy of the soil, possibly "also of the danger of exposing fæcal matter to be washed into the "river, or to be the pabulum of flies, which then settle upon "human beings and their food, and thus propagate disease."

The weight of dry sludge or "Poudrette" per 1,000 population, can be taken at 60 tons per annum, two-thirds of this is voided matter, the balance consisting of chemical compounds, soaps, etc., kitchen sink and factory refuse. This quantity will of course be materially increased, should there be many manufacturing establishments drained to the sewers.

Another decided advantage of "Poudrette" is that like guano, it can be drilled with the grain into the soil, thus saving the farmer the extra time and cost of hauling and spreading the

ordinary barn-yard manure, besides placing the fertilizer exactly where it is wanted. Owing to its porous nature, the Patent Carbon possesses the property of being able to occlude, condense and store away within its pores many times its own bulk of certain gaseous bodies, which it retains thus compressed in an otherwise unaltered condition, and from which they can be withdrawn as required like as from a reservoir.

The following analysis gives the absorbtive power of *one volume* of the Patent Precipitating Carbon:

	VOLUMES.
Ammonia	90.00
Hydrochloric Acid Gas	85.00
Sulphurous " "	65.00
Sulphuretted Hydrogen	55.00
Nitrous Oxide	40.00
Carbonic Acid	35.00
" Oxide	9.42
Oxygen	9.25
Nitrogen	6.50
Carboretted Hydrogen	5.00
Hydrogen	1.75

Taking the above figures it will be seen that one cubic foot of patent carbon is capable of storing without mechanical compression a little over 9 cubic feet of oxygen, representing a mechanical pressure of over 126 lbs. per square inch. Thus it will be seen that whilst its absorbtive powers are so great and manifest, it also possesses discriminating powers of selection as between these gases, for whilst the atmosphere contains nitrogen 4 times in excess of oxygen, it has been found that the mixed gases capable of being extracted from it, contain over 60 per cent. of oxygen. It is owing to these inherent properties that the precipitating carbon is so eminently valuable in the treatment of sewage and other foul liquids, and enables it to not only remove organic impurities, but also to destroy or render them of a harmless character.

We beg to append a few official and scientific opinions from well known authorities upon this system, and also refer to the works recently started for the Ontario Government at the Guelph Agricultural College, which are now in daily operation and are open by permission of the authorities to public inspection.

"HANTS' LABORATORY, May 13th, 1885.

"I have two glass jars in the Laboratory at the 'platform' "sewage tanks, Southampton, which give a significant illustra- "tion of the difference between the 'lime' process and the new "carbon process in regard to the effluent obtained from each.

"The sewage for both was taken on 20th April and has remained "up to 11th May in the sunlight, with the following varying "changes and results:

"No. 1.—The 'lime' process.—At first clear but yellow, with "some odour. Passed through rapid stages of putrefaction from "day to day, giving off an intolerable stench; very turbid, "bacteria and other organisms quite thick. Putrefaction then "came to an end and vegetation set up. Oxidation now com- "plete, odourless, but quite green.

"No. 2.—The 'New Carbon' process.—First bright, nearly "colourless, very slight odour, got brighter from day to day, *no* "*organisms appeared*; now quite odourless, and as *clear as dis-* "*tilled water.*

(Signed.) ARTHUR ANGELL, Ph. D., F.I.C.

DR. BARTLETT'S REPORT.

LABORATORY, Duke street, March, 1885,

THE PATENT CARBON.

"I find the 'Patent Carbon' to be highly porous, and to give results which are practically more than double the best obtained from wood charcoal, or from ordinary peat charcoal, while, in some respects, it is preferable to the high-priced animal charcoal.

"I omit the proportion of solids removed by the filtration, because these require a longer extension of experiment to do justice to the great superiority as yet shown in the comparison of the 'Patent Carbon' with the others tested. *But as regards* the removal *of organic matter in solution*, the *'Patent Carbon' is equal to the best animal charcoal*, and superior to the others. The decolorising properties of the 'Patent Carbon' being, for sewage effluent, very nearly equal to animal charcoal, and greatly superior to all others, this must be of the greatest value in the treatment of waste dye refuse."

(Signed.) H. C. BARTLETT, Ph. D., F.C.S.

Report of J. W. GATEHOUSE, ESQ., F.I.C., *Public Analyst of the City of Bath.*

THE CITY ANALYTICAL, LABORATORY,
36 Broad Street, Bath,
March 16th, 1885.

I have to report with reference to the properties of the Patent Carbon, that an extensive series of experiments shows it to possess filtering, deoderizing and decolorizing powers as nearly as possible analagous to, and identical with, those of Animal Charcoal.

The following series of experiments, in which a sample containing 50 per cent. of Carbon with 50 of Mineral matter was tested in conjunction with the best samples of Animal Charcoal and other Filtering Agents, will show this better than any other way.

In each case equal weights of material were used as the filtrant, the solution filtered being identical for each sample, and action continued for the same length of time.

TESTING THE COMPARATIVE DECOLORIZING POWERS OF ANIMAL CHARCOAL, THE PATENT CARBON, "CARFERAL," AND WOOD CHARCOAL BY FILTRATION OF INDIGO THROUGH EACH, IT WAS FOUND THAT THE DECOLORIZING POWER OF THE PATENT CARBON WAS IDENTICAL WITH THAT OF ANIMAL CHARCOAL, 10 PER CENT. BETTER THAN "CARFERAL," AND 60 PER CENT. BETTER THAN WOOD CHARCOAL, THE AMOUNTS DECOLORIZED BY EQUAL WEIGHTS OF EACH BEING IN THE PROPORTION OF 100, 100, 40, AND 50; the Patent Carbon maintaining its strength for an equal time to Animal Charcoal.

The Patent Carbon is also likely to be of considerable service to the Sugar Refiner, as it decolorizes sugar very perfectly, and at the same time does not retain more of the saccharine solution than Animal Charcoal itself.

My experiments for sugar refining with the samples reported on showed, that if the decolorizing power of Animal Charcoal be called 100, that of the Patent Carbon was 93, "Carferal" 45, and Wood Charcoal 25. Other samples of the Carbon used *soon after preparation* have been quite equal to Animal (the best) Charcoal, which is known to vary much in sugar refining power.

For decolorizing Mineral Oils my experiments show decidedly better results than with Animal Charcoal.

IN RESPECT TO SEWAGE AND WATER FILTRATION I FIND THE PATENT CARBON IS QUITE EQUAL (AND, INDEED, IN SOME RESPECTS SUPERIOR) TO ANIMAL CHARCOAL; IN FACT, TO ALL OTHER FORMS OF CARBON NOW IN THE MARKET.

The following Table gives the Composition of a sample of sewage in its natural state and after having been filtered through the Patent Carbon, Animal Charcoal and "Carferal" respectively.

Results given by 100,000 parts of sewage.	Total Solids in Solution.	Organic Matter in Solution.	Mineral Matter in Solution.	Oxygen required to effect decomposition.
Sewage before filtration..................	173.33	100.00	73.00	5.55
Sewage after filtration through the PatentCarbon., ...	**106.6**	**33.3**	**73.3**	**0.10**
Sewage after filtration through Animal Charcoal..........	166.6	33.3	133.3*	0.10
Sewage after filtration through "Carferal"........................	126.6	53.3	73.3	4.3

*The Phosphate of Lime in the Animal Charcoal has increased the Mineral matter.

It is seen by the foregoing Table that of the 5.55 parts of Oxygen which the Sewage required to render it innocuous, the new Patent Carbon and Animal Charcoal both supplied 5.45, thereby rendering it practically harmless; whereas "Carferal" supplied only 1.52.

The whole of the constituents of the sewage referred to in this table were in a state of solution, all suspended matters capable of extraction by mere mechanical filtration having been allowed to deposit before the commencement of the experiments.

IT IS THUS SEEN THAT, WHILST THE PATENT CARBON EXTRACTS FROM SEWAGE A GREATER AMOUNT OF TOTAL SOLIDS THAN EITHER OF THE OTHER FILTERING MATERIALS, IT AT THE SAME TIME SO OXIDIZES THE DECOMPOSING ORGANIC MATTERS AS TO RENDER THEM PRACTICALLY HARMLESS AND INODOROUS.

We thus have in this Carbon an oxidizing agent of the highest quality, and one which, unlike Animal Charcoal, may safely be used for the filtration of acid liquids, as the mineral matter contained in it is practically insoluble, whilst Animal Charcoal readily yields its Phosphate of Lime under similar conditions. It was this acid state of the sewage which caused it in the experiments above tabulated to contain more mineral matter after filtration through Animal Charcoal than before its use.

For water filtration this Carbon is highly preferable to Animal Charcoal, for whilst possessing equal filtering and oxidizing powers to this esteemed medium, its freedom from phosphates and soluble matters will check the growth of those minute organisms so frequently found in ordinary Charcoal Filters

Signed.) J. W. GATEHOUSE, F.I.C.
Public Analyst for the City of Bath, &c.

SUBSEQUENT MEMORANDUM.—"A sample of sewage effluent "filtered through the Patent Carbon has remained in my "Laboratory perfectly free from sediment and odour since the "date of its filtration on October 27th, 1884, up to the present "time (April 16th, 1885).

(Signed.) J. W. GATEHOUSE."

REPORT UPON THE PATENT CARBON POWDER AS A DEODORANT.

I have submitted this powder to an exhaustive examination, with a view to ascertain its properties as a deodorant. I find that its porosity gives it a very powerful action upon decomposing matter, both animal and vegetable. It is an active absorbent

and deodorizer of foul gases. These properties, which it possesses in a remarkable degree, qualify it as a valuable material for covering up Cholera, Typhoid and such like dangerous evacuations ; also for entrapping and destroying the noxious properties of sewer gases, and emanations from dead bodies.

It is useful in dry closets, and for general application where a deodorant is needed.

For the purpose of comparison with "Patent Carbon" I have chosen pure Animal Charcoal of the best quality I could obtain, and have made my experiments side by side, and under exactly the same conditions and circumstances, so that the results obtained may be relied upon, and the value of the trials easily estimated.

Expt. I.—ABSORPTION OF GASES (over Mercury)—

Animal Carbon	comparative value	100
Patent Carbon	" "	93

Expt. II.—DISCOLORIZATION AND DEODORIZATION OF FOUL LIQUID (Millowner's Waste)—

Animal Carbon	comparative value	100
Patent Carbon	" "	100

Expt. III.—REMOVAL OF SOAP FROM SOLUTION—

Animal Carbon	comparative value	61
Patent Carbon	" "	100

Expt. IV.—OXIDATION OF SULPHURETTED HYDROGEN IN SOLUTION—

Animal Carbon	comparative value	100
Patent Carbon	" "	100

Expt. V.—OXIDATION OF NITROGENOUS ORGANIC MATTERS—Quantitative experiment on "Millowner's Waste," containing 448 grains per gallon of Organic Matter, mostly in Solution—

	Grains per gal.	Comp. Val.
(1) Before Filtration—		
Saline Ammonia	28.00	3.0
Organic Ammonia	33.60	6.8
(2) After Filtration through Powdered Patent Carbon—		
Saline Ammonia	3.640	100.0
Organic Ammonia	2.128	98.7
(3) After Filtration through Animal Charcoal—		
Saline Ammonia	3.786	96.1
Albuminoid Ammonia	2.101	100.0

Mean Results : Patent Carbon 100.0 ; Animal Carbon 92.9.

Or leaving out of our calculation the results of the experiments on the removal of soap (not of much importance in most cases), we got—

Patent Carbon....99.1 ; Animal Charcoal....100.0.

These results show that the Patent Carbon is a very powerful oxidizing agent; in fact equal in its properties as a filtrant to the Best Animal Charcoal, and being free from phosphates, it is preferable for water filtration.

I enclose sample of prepared sewage sludge, obtained here by the use of the "Patent Carbon," as a precipitating powder. This powder contains only 9.65 per cent. of moisture. Such a powder cannot fail to be of value as a manure, especially that it is easily manipulated and applied to land.

A very important property in the Carbon, when used as a precipitant for sewage, is *its specific gravity, which being* 1.99 *as compared with water*, is so very much heavier than sewage, that it assists in dragging down quickly and thoroughly the coagulum formed by the chemical reaction. It also forms a denser sludge, which leaves a better marked line between the effluent and the sludge: the former, therefore, can be run off the more perfectly.

Yours truly,

ARTHUR ANGELL, PH.D., F.I.C.
Member of the Council of Public Analysts.

EXTRACTS FROM REPORT OF DR. C. T. KINGZETT.

London, Sept. 10*th*, 1885.

[N.B.—It may be mentioned that the opinion of Dr. Kingzett in this instance was sought by a gentleman who was anxious to safeguard his own interests before investing capital in the Patent Carbon Company.]

I was at considerable pains to determine the comparative value of the Patent Carbon as a deodorising and discolorising agent as applied to sewage, putrid extract of meat, and so forth, and from the results which I obtained I am satisfied that the Patent Carbon, in the form of powder, is, as nearly as possible, equal in action to animal charcoal when reduced to powder.

When in the form of powder, the Patent Carbon absorbs sulphuretted hydrogen and ammonia freely; it discolorises red wine, and putrid extract of meat, and it removes the unpleasant odour from sewage and many other evil smelling mixtures. In fact, I regard it as equal in value for these purposes with Animal Charcoal, over which, for use as a filtering medium of water, it has the decided advantage of being free from the presence of phosphates, which afford food for many forms of bacterial life.

(Signed) C. T. KINGZETT, F.I.C., F.C.S.
Vice-President Society of Public Analysts,
Past Member of Council Institute of Chemistry,
Author of "Nature's Hygiene," &c., &c.

BOROUGH ANALYST'S LABORATORY,

ROCHDALE, 19th Nov., 1887.

SEWAGE AND EFFLUENT WATER FROM SOUTHAMPTON.

NOTE.—This effluent water was obtained by means of *Carbon* as now in use at Southampton.

(*The figures refer to Grains per Gallon.*)

	Sewage.		Effluent.
Total Solids	99.2	..	55.6
Loss on ignition	36.0	..	8.3
Non-volatile matter	63.2	..	47.3
Combined Chlorine	16.1	..	16.4
Chlorine calculated to common salt	26.53	..	27.02
Free Ammonia	5.951	..	0.911
Albuminoid Ammonia	0.237	..	0.056
Hardness in Clark's degrees ..	21.7	..	20.5

The Effluent is *clear and bright.*—It gives off no smell, and *complies with the requirements of the Standards of the Rivers' Pollution Commissioners.*

(*Signed*) THOS. STENHOUSE, F.C.S.

A REVOLUTION IN THE TREATMENT OF SEWAGE.

[*Reprinted from* "INVENTION," *October* 30*th*, 1886.]

When we consider that the important question of the economic and sanitary disposal of the sewage of our great towns, after numerous fruitless attempts, and the utmost thought and labour expended on it by our scientists, sanitary engineers, and inventors, had up to this day remained unsolved, it is good news indeed to be able to announce that at last a process has been discovered which effectually meets all the difficulties of the case, and, most important of all, has been proved to do so by practical experiments of considerable duration. Thursday last week, in fact, marked the end of the experimental stage of the sanitary works belonging to the Corporation of Southampton, in which the new process has been successfully carried out during the last six months, for on that day a number of scientists and engineers from

the metropolis, and surveyors of corporations from all parts of the country, were invited by the directors of the Patent Carbon Company, whose chemical material may be said to form the most important, in fact indispensable, feature in the new process, to pronounce upon the merits of the invention. That verdict was emphatically favourable, and it was agreed on all hands that the system introduced by the Corporation of Southampton presents the complete solution of the problem, and will produce a revolution in the treatment of sewage. The conviction so generally produced amongst a most influential and competent assembly fully justified the course adopted by the inventor of the "Patent Carbon," in conjunction with the borough surveyor of Southampton, who carried out the scheme for the Corporation, of giving publicity to the process only after it had been tested by practical application during an adequate period. Not that the scheme was a secret, for the Metropolitan Board of Works have taken the deepest interest in the development of the works, with the view of adopting a similar system in some parts of the metropolis; and so widespread has been the interest felt in the carrying out of the experiments that the German Embassy recently sent down one of their scientific *attachés* for the purpose of preparing a special report to be sent to the Government Bureau at Berlin. The new works, the foundation stone of which was laid in December last, are over a mile from the "platform," near the Town Gate, whence the effluent is passed in iron tubing beyond the limits of low-water mark. The site was a swampy space, upon which the refuse of the town was formerly carted, and formed a serious nuisance. Here has been erected a Destructor, with six furnaces, in which all the combustible refuse from the town is burned, giving steam-power to a 30 horse-power engine, which is mainly used for compressing air for the removal of the sludge collected in the two settling tanks at the "platform." These tanks are each 100 feet by 60 feet, and over 20 feet deep, and before the sewage reaches them it is mixed with a novel clarifying material denominated "patent carbon," a material which appears to exercise a most remarkable influence in the main sanitary purposes of deodorising the sewage and oxidising the organic matter it contains without fermentation or putrefaction. The effluent is non-alkaline, or only exceedingly slightly so, and vegetation will, it is said, grow in it without any further or secondary chemical change. The use of the two tanks, one filling and one discharging alternately, allows the flow through the sewers to be constant without interruption; and by the application of compressed air to an ejector the sludge is forced in a five-inch pipe from the "platform" to the works, where a valuable manure is made. The

sewage thus dealt with (at present) amounts to 500,000 gallons per day; the effluent is inodorous and purer than the estuary water. The sludge—which hitherto has been intractable with the lime and slum-cake processes, as being neither able to be consumed without offensive emanations, nor being able to be compressed into properly solid cakes—is by the carbon produced in a granular state, and can either be dried naturally or artificially by heat, when it is, without further treatment, fit for application to the soil, of which it will thenceforth form an integral and permanent portion.

We have already stated that the most important feature in this new process is the chemical medium with which the sewage is treated. To the discovery of this medium the inventors had for years applied themselves. It was the question of discovering a material which should not only solve the problem, but also be obtainable in sufficient quantity and at such moderate cost as would make the process thoroughly successful. This material was, after the most exhaustive research and experiments, discovered in the deposits of lignite in Devonshire. The "carbon" is an artificial product made from this lignite, and contains such percentages of alumina and iron as rendered it of about twice the specific gravity of water. It thus acts like lime as a precipitant, whilst, by means of the porosity of the carbon, oxygen is abundantly included. This carbon is ground to a fine powder, and, mixed with water as a flux, is run into the sewage as it flows along. The fine division of the carbon brings the oxygen into close community with the fine organic particles through the entire mass of the sewage, so that oxidation is effected in the most complete manner. What is all the more remarkable about this discovery is, that this lignite was well known to our geologists and scientific authorities, but that it has until now been a waste product for which no use could be found. Nor did the inventor discover the peculiar properties of this substance until all his manifold experiments with other materials, for which he employed chemists and analysts in all parts of the country, were exhausted. The preparation of the compound constitutes a process which is protected by five patents. Here then is one of the most remarkable instances of nature working for mankind, and achieving much better and at a nominal cost what could not be done by the most consummate skill of modern chemistry.

On these lignite deposits we find an interesting article, entitled "An Ancient Lake Bottom," by Grant Allen, in *Longman's Magazine* for June, 1884. This geological monument lies in a remote corner of the Dartmoor district, just below the twin granite peaks of water-worn Hey Tor. According to the geological account of

the supposed-formation of these deposits in the above article, there is reason to believe that the Dartmoor ranges which skirted the " Bovey Lake " were much higher in those remote times than now, and closed the lake in with rank tropical vegetation. Through subsequent climatic changes this vegetation became disintegrated, and was worked down into the lake, there being formed a basis of silicate of alumina and iron, which is well known to be a prime agent in the precipitation of sewage They cannot, however, by artificial means be, at the present day, assimilated with carbon, as in these lignite deposits, where nature has performed the process. It is precisely this blending of the charcoal with the chemical agents which makes this carbon so valuable for the treatment of sewage.

The experiments made have proved finally that an artificial combination could not effect what nature has in this case accomplished. It is therefore a result which it is not possible to imitate by art. It is precisely the maximum of porosity attained in these deposits which gives the oxydizing effect in so perfect a manner. We may here state that the early experience of the experimenters was that they could not prevent a pulp being formed when the material was placed in the liquid, and that the attainment of that firmness of structure maintaining itself in the liquid which has now been obtained by the inventors appeared for many weary months a hopeless task. It is a curious circumstance that nature should have produced in this lignite precisely that substance of a body just a fraction under double the specific gravity of water, which thus fulfils the purpose in so remarkable a degree.

After the success achieved in Southampton there can be no doubt that the process will be introduced on the widest possible scale throughout the country, and we may therefore consider the prospects of the company which has just been formed to work the invention as most favourable. This company has a share capital of £100,000, and purposes extending the present means of production and working the material on a greatly enlarged scale. The whole of the patent rights have been acquired.

Copy of Testimonial from DR. ARTHUR ANGELL, *Ph.D., F.I.C., Public Analyst, County Laboratory, Southampton.*

ON DEODORISING CARBON.

THE COUNTY LABORATORY, SOUTHAMPTON,
4, PORTLAND TERRACE,
April 6th, 1887.

Report on the Examination of a Sample of Deodorising Carbon received from the Patent Carbon Co:

This Powder I find to be an excellent deodorizer by oxidation. It immediately robs the most filthy gases of their odour and of their deleterious properties, and at the same time is perfectly innoxious and inodorous itself.

It is well adapted for use as an antiseptic in cases of zymotic diseases, or where dangerous putrescant matter needs immediate disinfection.

I hereby certify that the above is a statement of the result of my own Analysis.

As witness my hand 6th day of April, 1887.

ARTHUR ANGELL, *Ph.D., F.I.C.,*
Public Analyst for Hampshire, Newport, Guildford, Basingstoke, Winchester, and Andover.

Extract from Report of W. B. G. BENNETT, *Borough Engineer,* Southampton, *dated* 19*th Oct.*, 1888.

The works have now been in operation over 2½ years without hitch, and the Corporation are so extremely satisfied with their success that they have instructed me to prepare the plans and estimates for the extension of the system to the remainder of the Borough, at once, upon which work I am now engaged.

The treatment of the sewage with the carbon which we have been using since the commencement of the works, is still giving the same satisfaction.

When the system is extended to the whole borough, we shall treat about four million gallons in the 24 hours.

The object of the works was to prevent pollution of the Solent, which prior to their introduction daily received the sewage in its crude state.

Now, and for the past $2\frac{1}{2}$ years, that has been remedied, only bright, clear water being discharged into the river.

(Signed) W. B. G. BENNETT.
Borough Engineer.

SEWAGE TREATMENT AT SOUTHAMPTON.

[*Reprinted from Iron of October* 29, 1886.]

The great question in sewage disposal is how to perfectly arrest and retain all the manurial portions of sewage, delivering them both in an innocuous and a dry and saleable form at a moderate cost, at the same time obtaining a pure effluent. In this respect, it may be broadly stated that, with but few exceptions, all attempts in this direction have practically failed. The question, however, appears to have met with a practical solution at Southampton, where a very comprehensive scheme of sewage disposal has been devised and carried out. The secret of the success which has undoubtedly been attained there lies in the use of carbon, not carbon in its ordinary form, but carbon prepared from a special substance, and by a special process. This material is patent carbon. It is prepared from a natural product which is obtained in Devonshire, and which, after treatment, is found to be rich in available iron alumina, and carbon. By the special process the metals are rendered soluble, and by this means what appears to be the most perfect chemical precipitant is produced. It possesses the property of precipitating and oxidising solids and organic matter in solution, and of purifying the liquids of sewage. In itself, it is perfectly inodorous, but it immediately destroys all noxious smells, and effects a nearly perfect purification of the effluent water, which does not afterwards become foul by chemical reaction. Carbon, moreover, produces a sludge which is at once manageable and saleable.

Having referred so far to the means employed, we will next describe the method of its application, as we recently found it at Southampton, where it has been in use for the past eighteen months. The system of sewage disposal at Southampton, however, involves several other points, and the works for carrying out the system as a whole were visited on October 21 by a large party of scientific and other gentlemen representing the Metropolitan Board of Works, various provincial corporations, and numerous sanitary authorities. The visitors, to the number of

over a hundred, on arriving at the sewage works, were received by the Mayor and Corporation. Although the carbon process has been in use for eighteen months, the scheme of sewage treatment as a whole has only recently been completed, and the inspection therefore took the form somewhat of an opening ceremony. At Southampton, the sewage flows to a point known as the Platform, which is situated on Southampton Water, and is, in fact, the outfall for the sewage. Before reaching the Platform the carbon, in the form of a black power, is mixed with water and discharged into the sewer. At the Platform are two precipitating tanks, which are worked alternately, the sewage flowing into one until it is full, and then being left to rest during precipitation. The flow of the sewage is then diverted to the second tank, and when the charge in the first tank has become settled, the effluent water is discharged into Southampton Water by the aid of pneumatic ejectors, and the precipitate, or sewage sludge, is forced by another of these ejectors to a portion of the works at Chapel Wharf, about a mile away. The effluent water is fairly clear—that is, it is about as clear as the water into which it is discharged, and is perfectly devoid of any offensive smell, being thoroughly deodorized, as was demonstrated upon the inspection. The tanks at the platform receive the sewage of a district containing about 13,000 inhabitants, and the accumulation in the tanks amounts to about 500,000 gallons in the twenty-four hours.

After the engineer had explained the process of deodorisation and precipitation of the sewage and the ejection of the effluent water from the tanks in one direction, and of the sludge in another, the visitors proceeded to Chapel Wharf. On reaching this point, the mayor started the engine which is used in connection with the ejectors, and the works as a whole were declared to be duly inaugurated. The works were then inspected, and the visitors here found the treacle-like sludge (which, like the effluent water, is devoid of any noxious smell) flowing into a tank. It is found to make an excellent manure, and in addition to its chemical properties it possesses the mechanical property of adding to the lightness and porosity of the soil by reason of the presence of the particles of earthy carbon. At Chapel Wharf, a six-chamber destructor has been constructed, for getting rid of the house refuse and garbage of the town by burning, which it does most effectually. The products of combustion are led from the destructors to a chimney, and on their way are utilized in raising steam in a 30-horse boiler for driving the engine which compresses the air for the ejectors, the boiler being placed in the flue.

Such is the method by which the sewage difficulty has been successfully overcome at Southampton, and by which it follows that the same difficulty could be overcome elsewhere. It will be seen that the scheme comprises three essential points, viz., the precipitation of the solid particles of the sewage by the carbon; the discharge of the innocuous effluent into Southampton Water and the transmission of the sludge to Chapel Wharf by ejectors, and the conversion of the sludge into solid dry manure. The system reflects every credit on the municipal authorities of Southampton and their engineer, and the results were pronounced to be highly satisfactory by the sanitary authorities present. Practical experience there shows that the carbon constitutes a very effective precipitating agent, and that it has *effectually set at rest the sewage question*, and a strong recommendation in its favour is that it is economical. As a matter which appears to us to involve issues of the highest importance to the community at large, we cannot too earnestly press it upon the attention of every sanitary authority.

Extract from "THE LANCET" *of London, No.* 26, *Vol. I.*, 1889
No. 3435, 29*th June*, 1889, *Page* 1318.

WATER POLLUTION AT ENFIELD.

Considerable anxiety prevails amongst some of the residents of Enfield, owing to the occurrence of a recent pollution of the public water service, and to the absence of proper assurance that such action has been taken as will prevent any such recurrence.

The pollution appears to have been due to percolation into the well from the neighbouring sewage farm, and public notices have been issued warning people not to drink the water except after boiling and filtration.

This is naturally an alarming state of affairs, and the local board owe it to the public forthwith to state what is being done in the matter.

FLIES AS CARRIERS OF DISEASE.

The conclusions reached by Messrs. Maddox, Grassi, Manson, and Doraine on the anti-sanitary action of flies (Slater's Sewage Treatment, pages 62, 63), have been recently re-examined and fully confirmed by M. G. Alessi, Revue Scientifique. He under-

took to examine if these creatures can collect the microbes of tubucular consumption and take part in their distribution. After having collected the matter expectorated by consumptive patients, and fed flies upon it, he examined the intestines of these insects under the microscope, and discovered in them the tubercular bacilli in plenty, as also in their extractions. The bacilli, are alive and active. If inoculated into living animals, they multiply and produce the ordinary well-known symptoms.

The microbia of cholera, of typhoid fever, and splenic fever, likewise, are absorbed by flies, and after passing through the bodies of the latter, retain all their vitality and virulence.

The following are a few short extracts relative to different systems now and formerly in use:

"Amongst the other methods tried at the Platform was the "ordinary process of precipitation by lime, but this utterly broke "down in consequence of the foulness of the effluent. Samples of "the effluent by the Carbon Process, taken from the tanks are pra- "tically colourless and inodorous."

"BENNETT."

"Nothing is more certain than that the discharge of crude "sewage into a river is inadvisable. It is, in fact, a method of "shifting a nuisance from the nuisance producer to his immedi- "ate neighbour. The evils arising from such discharge depend "mainly upon the suspended matter in the sewage. This, first of "all, floats about near the outfall, certain portions of the organic "matter combining with aluminous compounds from alluvial mud "raised by tides and steamers. In time deposition takes place. "In the course of flow the various ingredients are found to deposit "more or less in the order of their specific gravity.

"The first deposits are mainly mineral with small quantities of "organic matter carried down at the same time. The later de- "posits are mostly finely divided organic matter, along with a small "quantity of mineral matter. Thus there occurs, as the result of "flow, a natural starting of the matters in suspension.

"The organic impurities of the sewage in this manner collect "in the bed of the river and ultimately putrefy. The gases de- "veloped and bottled up in time render the solids sufficiently "buoyant to rise to the surface, where the gases of putrefaction "(sulphur and phosphorous compounds for the most part) are "given off, the solid matter again sinking to undergo fresh putre- "factive changes. Thus the nuisance from the discharge of sew-

"age into the river (or water way) may be far more offensive at a "short distance from the outfall than at the outfall itself."

"The River Pollution Commissioners admit that odors do "arise from land irrigated with sewage, day after day, for years. "The Craigentinny meadows, near Edinburgh, can only be "described as filthy, emitting a stink hardly endurable. "The surgeon to the barrack adjoining the meadows, described "the stench (1868) as 'sickening.' Of the Croyden sewage "farm at Beddington Dr. Cressy, surgeon to the orphan asylum, "stated that 'typhoid fever had been in every cottage on the "estate'—every disease in fact assuming a particular type, accom- "panied by what is called a 'sewage tongue.' In fact, the stink "of sewage-irrigated ground and the malarious effects of the sewer "gases evolved, are matters of frequent complaint and litigation. "Dr. Clouston traced an outbreak of dysentery in the Cumber- "land asylum to the effluvia of a sewage farm.

"There is, too, a remarkable statement by Copland, that the "effects of sewer gases are never so bad as when emitted from "sewage spread out upon the land. This statement is worthy of "consideration. Solid matter is given off during evaporation. As "the turpentine in lead paint is evaporating, solid lead carbonate "is carried into the air, and produces lead poisoning amongst the "inmates of the freshly painted house. This cannot result from "any volatility of the lead, but merely from the mechanical dis- "lodgement of lead particles during the evaporation of the vola- "tile constituents of the paint. For when the smell has gone, the "danger has passed. The sanitarian recognizes the importance of "defecating the excreta of the typhoid patient, as soon as evacu- "ated, and of removing it from the sick room without delay, and "why? to prevent the *materies morbi* being carried into the air "during the evaporation of the liquid portion. It must, there- "fore, be an unscientific method to spread the sewage of a mixed "population over the land, thereby increasing the area of evapora- "tion. Mr. Hawksley's words may be quoted here:

"They are the record of one whose unique experience is only "rivalled by his acute powers of observation: 'Water irrigation "carried on in warm weather is exceedingly unhealthy. I can "speak positively to it from repeated observation in different "places, that the odor, particularly at night and upon still damp "evenings in autumn, is very sickly indeed, and that in all these "cases a great deal of disease prevails. The sewage forms a de- "posit on the surface of the ground, that deposit forms a cake of "organic matter, and organic matter when it is in a damp state, "as it usually is, gives off in warm weather a most odious stench.

"The grass covered with sewage, eaten as it is with rapacity by

"cattle, infects their bodies with the larval parasites. Thus the "meat is measly, and measly meat, except for efficient cooking, "means tapeworm to the human subject.

"DR. C. MEYMOTT TIDY."

Mr. Slater, in his celebrated work on sewage treatment, states that experiments were tried by Mr. Smee to test the result of feeding cows on sewage-irrigated grass as follows:

"Two cows were set aside for experiment. The one, which "we may call A, was fed on sewage irrigated grass, and the other, "B, on grass from an ordinary meadow. The milk obtained from "each cow was kept separate and examined. It was found that "the milk of A became not merely sour, but it putrefied and stank "much sooner than that of B. It was noticed that a favorite cat, "exceedingly dainty in its tastes, entirely refused to lap the milk "of A. The butter from A's milk became rapidly rancid as com- "pared with butter obtained from cows fed on ordinary pasturage. "Cream from the milk of A required, in three successive lots 1½, "1½ and 2½ hours to churn, and the butter was soft and smeary. "Check samples of cream from cows fed on normal food required "only 35 minutes, 1¼ hour, and ¾ hour to churn, and the butter "was firm. So far, of course, this experiment is open to the objec- "tion that the bad quality of the milk and butter from A was "due to some morbid condition in herself rather than in her food. "To meet this doubt, Mr. Smee reversed the experiment, feeding "B on sewage grass and A on normal herbage. He also tried "other cows, still the results reached were practically the same, "the milk from every cow fed on sewage grass was notably more "prone to putrescence than that from cows fed on common meadow "grass.

"Mr. Smee made further experiments on the grass itself. He "found that the juice of sewage grass became more quickly and "more offensively putrid than that of common grass. Hay made "from sewage grass, if kept in a vessel of water in a warm place, "quickly set up a putrid fermentation, whilst hay from ordinary "grass treated in the same manner behaved quite differently.

"It should be remembered that when it not long ago seemed "probable that the cholera might visit Paris, the inhabitants were "formally warned by the sanitary authorities against consuming "vegetables from the sewage irrigation farm at Gennevilliers."

The ancient city of Chichester has long had the question of sewage disposal in the hands of an expert committee, and has at

last adopted the patent precipitating carbon system in preference to any other. After personal investigation, the Committee stated their decision as follows: "That they consider the Southampton system to be the best they have seen, and furthermore find that "by drainage the sanitary condition of a town is materially im-"proved, the health of the inhabitants benefited, and the death "rate reduced.

"That the value of property in such towns has been thus in-"creased.

"That the extension of towns is so facilitated. That it tends "to commercial prosperity. That beyond the other more impor-"tant considerations, drainage is an economical measure, the ad-"ditional rate being more than compensated by the saving of the "continual outlay required in connection with old cesspits and "defective sanitary arrangements.

"The consulting Engineer reported (11th Sept., 1889) the special "process I should use for the treatment of the sewage is the ad-"mirable one now in use at Southampton."

The city of Salford, near Manchester, has lately tried the Carbon process and a report just received states: "The effluent is as clear as the best drinking water, absolutely free from smell, and there is not the least trace of anything to indicate that it was anything but ordinary water; the authorities were astonished with it."

Hastings, Parkhurst Barracks, Coventry, Brentford, Richmond, Shirley, Worcester (at this place the "Condor" system was rejected by the War Office authorities and the "Carbon" system adopted), and many other places all use "Patent precipitating Carbon." The system has been on daily exhibition in this city (Toronto) for nearly eleven months past in the basement of the city hall, where by kind permission of the city hall officials, it has been visited by large numbers from all parts of the country, the result being so highly satisfactory and the entire process so simple showing the crude sewage as daily pumped from Jarvis street sewer, converted within a short time into bright, clear, inodorous, effluent water, and a precipitate of dense, perfectly disenfected sludge, many visitors actually drinking the water and pronouncing it devoid of all taste and practically equal to our water supply. This exhibition is now closed owing to the works at the Government College at Guelph being on a larger scale and performing the work in a highly satisfactory manner.

There is not a city, town or village in this country to-day but which stands badly in need of sanitary purification; our larger cities and towns which drain into the lake are gradually but surely polluting that magnificent body of water, the rippling

action of running streams does not here apply, and as shown by scientific men who have made such matters a life-long study, and notwithstanding statements made by interested quasi-scientists to the contrary, the proof is observable in the ever increasing dearth of fish from around, and, in fact, within several miles of the respective sewage outfalls. Sewage matter may be diluted, and certain portions, provided they drift away, may not be detrimental to health, but the microbia voided from patients suffering from infectious deseases or the bacterial life developed during decomposition, are not destroyed and remain to be taken into our systems, either in the water supply, in ice, or, having been expelled into and diffused through the air by the bursting of gas bubbles on the water and emanating from the fetid deposit below are inhaled, and so reproduce the diseases from which they were originally derived.

Some situations are of course better adapted for sewage disposal than others, but there is no place on this continent where a perfect and every-day working system cannot be established, and the object this company has, is to undertake all such work, and by the long practical experience of its executive officers in many countries, to apply the knowledge so acquired to the perfect development and final completion of this class of sanitary engineering.

The destruction of all garbage and house-refuse is as much a necessity as the proper disposal of sewage, and by using a properly constructed furnace, fitted with the patented attachments which have proved so satisfactory in England, the total destruction of all refuse is not only carried on without smell, but sufficient of the heat is utilized to raise steam in boilers, built into the "destructor" to furnish all the power necessary for the different operations of this process.

USEFUL INFORMATION.

Weight and capacity of different standard gallons of water.

	Cubic inches in a gallon.	Weight of a gallon in pounds.	Gallons in a cubic foot.	Weight of cubic foot.
Imperial	277.274	10.	6.232	62.321
United States..........	231	8.331	7.48	
New York	221.819	8.	7.9	

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434.

To find (approximately) *the flow of water from circular pipes*, multiply the area in inches by .0434, the result will be Imperial gallons discharged per second, at a velocity of *one foot per second.*

Doubling the diameter of a pipe, increases its capacity *four times.*

Friction of liquids in pipes increases as the square of the velocity.

The *mean pressure* of the *atmosphere* is usually taken at 14.7 lbs. per square inch, so that with a perfect vacuum it will sustain a *column of mercury* 29.9 inches, or a *column of water* 33.9 feet high.

TABLE OF RELATIVE CAPACITIES OF PIPES, BY J. T. FANNING, C. E.

The following table of approximate relative discharging powers of pipes, will facilitate the proper proportioning of systems of pipe distributions. It shows at a glance the ratio of the square root of the fifth power of any diameter, from 3 to 48 inches, to the square root of the fifth power of any other diameter within the same limit.

In the second column of this table, the diameter 1 foot is assumed as unit, and the ratios of the square roots of the fifth powers of the other diameters, *in feet*, are given opposite to the respective diameters in feet written in the first column.

Thus the approximate relative ratio of discharging power of a 3-foot pipe to that of a 1-foot pipe is as 15.588 to 1; and of a .5-foot pipe to a 1-foot pipe as .1768 to 1; also the relative discharging power of a 4-foot pipe (= 48-inch) is to that of a 2-foot pipe (= 24-inch) as 32 to 5.657; and of a 2.5-foot pipe to the combined discharging powers of a 2-foot and 1.5-foot pipes as 9.859 to (5.657 + 2.756).

The last vertical column gives the diameters in inches, as does also the horizontal column at the head of the right-hand section of the table.

The numbers in the intersections of the horizontal and vertical columns from the diameters in inches give also approximate relative discharging capacities. For instance, if we select in the vertical columns of diameters that of the 48-inch pipe, and desire to know how many smaller pipes it is equal to in discharging capacity, we trace along the horizontal column from it, and find that it is equal to 15.59 sixteen-inch pipes, or 5.65 twenty-four-inch pipes, or 1.58 forty-inch pipes, etc.; also, for other diameters, we find that a 24-inch pipe is equal to 32 six-inch pipes, or 2.05 eighteen-inch pipes, and a 12-inch pipe is equal to 5.65 six-inch pipes.

RELATIVE DISCHARGING CAPACITIES OF FULL SMOOTH PIPES.

DIAM. IN FEET =d	RELATIVE DISCHARGING POWERS $=d^{\frac{5}{2}}$	3	4	6	8	10	12	14	16	18	20	22	24	27	30	33	36	40	44	48	DIAM. IN INCHES
4.	32.								15.59	11.61	8.92	7.03	5.65	4.21	3.24	2.55	2.05	1.58	1.24	1.	48
3.667	25.75							17.50	12.54	9.34	7.17	5.66	4.55	3.39	2.61	2.00	1.65	1.27	1.		44
3.333	20.235						20.23	13.47	9.85	7.34	5.64	4.44	3.57	2.66	2.05	1.65	1.26	1.			40
3.	15.588						15.58	8.41	7.59	5.65	4.34	3.42	2.74	2.05	1.58	1.24	1.				36
2.750	12.541				34.55	19.78	12.54	8.52	6.11	4.55	3.49	2.75	2.21	1.65	1.27	1.					33
2.50	9.859				27.09	15.54	9.85	6.54	4.80	3.57	2.74	2.16	1.74	1.29	1.						30
2.25	7.594			42.95	16.61	9.96	7.59	5.16	3.70	2.75	2.11	1.67	1.34	1.							27
2.	5.657			32.00	15.58	8.92	5.65	3.84	2.75	2.05	1.57	1.24	1.								24
1.833	4.549		70.96	25.73	12.53	7.17	4.55	3.09	2.16	1.65	1.26	1.									22
1.667	3.588		55.96	20.29	9.88	5.66	3.58	2.43	1.74	1.30	1.										20
1.5	2.756		42.01	15.58	7.25	4.34	2.75	1.87	1.34	1.											18
1.333	2.052	65.77	32.01	11.60	5.65	3.23	2.05	1.39	1.												16
1.167	1.471	47.14	22.94	8.32	4.05	2.32	1.47	1.													14
1.	1.	32.05	15.60	5.65	2.75	1.57	1.														12
.8333	.6339	20.31	9.88	3.58	1.74	1.															10
.6667	.3629	11.63	5.66	2.05	1.																8
.5	.1768	5.66	2.75	1.																	6
.3333	.0641	2.05	1.																		4
.25	.0312	1.																			3

AREAS OF CIRCLES.

ADVANCING BY EIGHTHS.

DIAM.	.0	.⅛	.¼	.⅜	.½	.⅝	.¾	.⅞
0	.0	.0122	.0490	.1104	.1963	.3068	.4417	.6013
1	.7854	.9940	1.227	1.484	1.767	2.073	2.405	2.761
2	3 141	3.546	3.976	4.430	4.908	5.411	5.939	6.491
3	7.068	7.669	8.295	8.946	9.621	10.32	11.04	11.79
4	12.56	13.36	14.18	15.03	15.90	16.80	17.72	18.66
5	19.63	20.62	21.64	22.69	23.75	24.85	25.96	27.10
6	28.27	29.46	30.67	31.91	33.18	34.47	35.78	37.12
7	38.48	39.87	41.28	42.71	44.17	45.66	47.17	48.70
8	50.26	51.84	53.45	55.08	56.74	58.42	60.13	61.86
9	63.61	65.39	67.20	69.02	70.88	72.75	74.66	76.58
10	78.54	80.51	82.51	84.54	86.59	88.66	90.76	92.88
11	95.03	97.20	99.40	101.6	103.8	106.1	108.4	110.7
12	113.0	115.4	117.8	120.2	122 7	125.1	127.6	130.1
13	132.7	135.2	137.8	140.5	143.1	145.8	148.4	151.2
14	153.9	156.6	159.4	162.2	165.1	167.9	170.8	173.7
15	176.7	179.6	182.6	185.6	188.6	191.7	194.8	197.9
16	201.0	204.2	207.3	210.5	213.8	217.0	220.3	223.6
17	226.9	230.3	233.7	237.1	240.5	243.9	247.4	250.9
18	254.4	258.0	261.5	265.1	268.8	272.4	276.1	279.8
19	283.5	287.2	291.0	294.8	298.6	302.4	306.3	310.2
20	314.1	318.1	322.0	326.0	330.0	334.1	338.1	342.2
21	346.3	350.4	354.6	358.8	363.8	367.2	371.5	375.8
22	380.1	384.4	388.8	393.2	397.6	402.0	406.4	410.9
23	415.4	420.0	424.5	429.1	433.7	438.3	443.0	447.6
24	452.3	457.1	461.8	466.6	471.4	476.2	481.1	485.9
25	490.8	495.7	500.7	505.7	510.7	515.7	520.7	525.8
26	530.9	536.0	541.1	546.3	551.5	556.7	562.0	567.2
27	572.5	577.8	583.2	588.5	593.9	599.3	604.8	610.2
28	615.7	621.2	626.7	632.3	637.9	643.5	649.1	654.8
29	660.5	666.2	671.9	677.7	683.4	689.2	695.1	700.9
30	706.8	712.7	718.6	724.6	730.6	736.6	742.6	748.6

HUNTER, ROSE & Co., Printers.

$\frac{7}{8}$
.6013
2.761
6.491
11.79
18.66
27.10
37.12
48.70
61.86
76.58
92.88
110.7
130.1
151.2
173.7
197.9
223.6
250.9
279.8
310.2
342.2
375.8
410.9
447.6
485.9
525.8
567.2
610.2
654.8
700.9
748.6